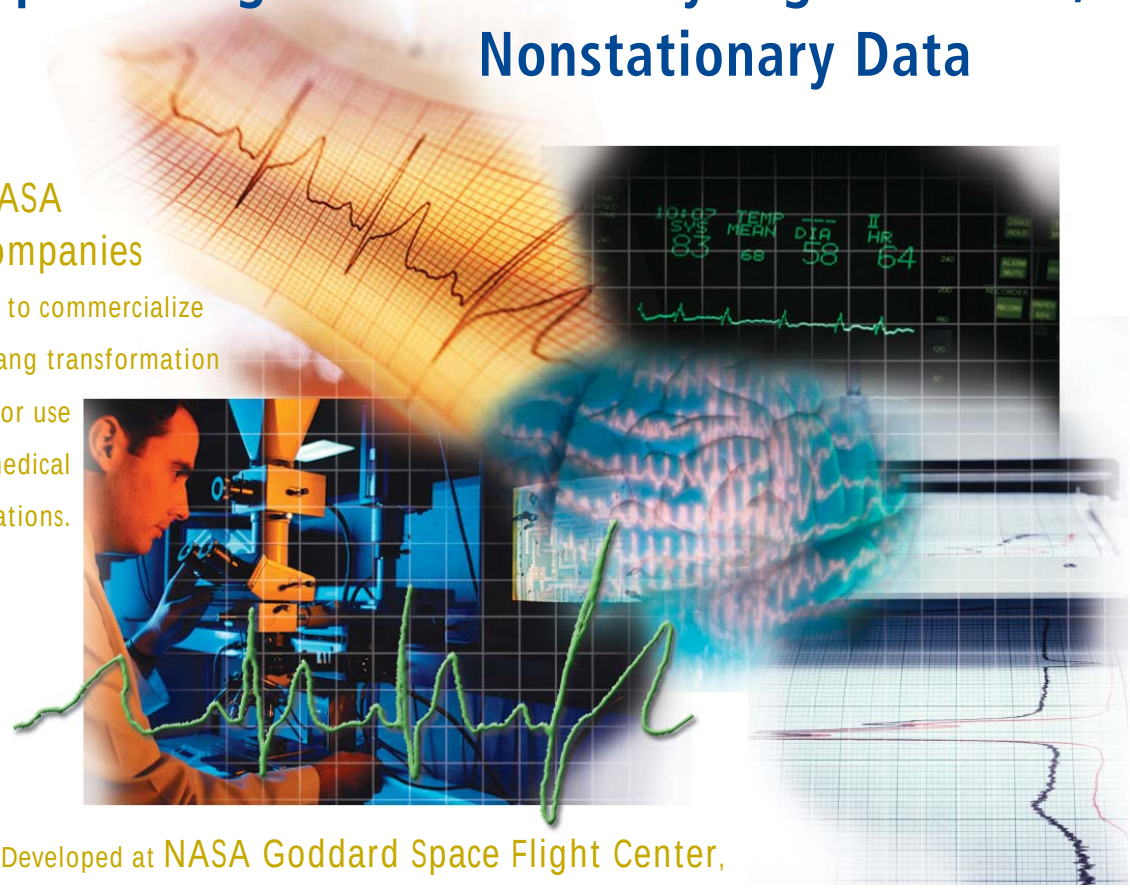
DATA PROCESSING TECHNOLOGY

Superior Algorithms for Analyzing Nonlinear, Nonstationary Data



NASA offers companies the opportunity to commercialize the Hilbert-Huang transformation technology for use in biomedical applications.

Developed at NASA Goddard Space Flight Center, the Hilbert- Huang transformation (HHT) technology is a highly efficient, adaptive, and user-friendly set of algorithms capable of analyzing time-varying processes. Designed specifically for nonlinear and nonstationary signals, HHT can be used to analyze data for the purpose of diagnosing or monitoring physiological conditions. The algorithms also provide increased accuracy when used to analyze linear and stationary signals.

Benefits

- ***Precision:*** More precise analysis of signal data and sharper filter performance than provided by Fourier-based methods
- ***Flexibility:*** Capable of processing both linear and nonlinear and stationary and nonstationary signals with great accuracy
- ***Accuracy:*** Preserves the intrinsic properties of the data, rather than forcing the data to fit a preselected basis, as in Fourier methods
- ***Easy implementation:*** Easy and inexpensive to implement in software or hardware
- ***Real time operation:*** Operates and yields physically meaningful results in real time
- ***Multifunctionality:*** Generates analytic functions for a data set where other methods fail; generates previously unattainable data for aiding in diagnosis; and provides new, quantitative measurements that enhance understanding of underlying physiological phenomena

National Aeronautics and Space Administration

Commercial Applications

- Analysis of acoustic, biological, and physiological signals (e.g., blood pressure, heart pulse interval, heart rate, plethysmogram signals, electroencephalogram (EEG) signals, temperature signals, blood oxygen levels, speech analysis, electrocardiogram (ECG))
- Noise filtering (i.e., reducing noise and increasing signal clarity)
- Identification of outliers (i.e., in heart rate, blood pressure, and other physiological functions)
- Deriving an analytical function representative of a biological phenomenon
- Studying the effect of one variable on another to obtain a deeper understanding of the underlying physiological phenomenon
- Diagnosis of an abnormal condition or disease (e.g., sleep apnea, neurological disorders such as epilepsy and Parkinson's disease)
- *In vitro* studies such as current flow across membranes (patch clamping), fluorescence in confocal microscopy, analysis of spectroscopic signals
- Drug discovery (e.g., to assess protein structure and protein-protein interactions)
- Tissue engineering and design

Partnering Opportunities

This technology is part of NASA's technology transfer program. Companies are invited to consider partnering with NASA to implement the Hilbert-Huang transformation technology in biomedical applications.

The Technology

This new tool was specifically designed for analysis of nonlinear, nonstationary data. The HHT algorithms accurately analyze physical signals via the following steps:

1. Instantaneous frequencies are calculated based on the Empirical Mode Decomposition method when intrinsic mode functions (IMFs) are generated for complex data.
2. A Hilbert transform converts the local energy and instantaneous frequency derived from the IMFs to a full energy-frequency-time distribution of the data, (i.e., a Hilbert spectrum).
3. The physical signal is filtered by reconstruction from selected IMFs.
4. A curve can be fitted to the filtered signal (curve fitting might not have been possible with the original, unfiltered signal).

Winner of the Federal Laboratory Consortium (FLC) award for excellence in technology transfer, this technology is a highly efficient, adaptive, and user-friendly general computational method. Compared to current transform methods and technologies, HHT offers improved accuracy and yields results with more physical meaning than existing analysis tools that tend to obscure or discard valuable information. HHT can be used to:

- Analyze physiological signals from various bodily systems: HHT can be tailored to the desired medical application (i.e., generating analytic functions for a data set; assisting in diagnosis or monitoring; analyzing data to understand an underlying phenomenon).
- Examine medical phenomena such as sleep apnea, epileptic seizures, blood pressure variation, and the effects of hypoxia on blood pressure: HHT has produced results in the laboratory not previously available to researchers.
- Enable medical researchers to better understand and characterize the underlying phenomena: HHT can aid in the diagnosis and monitoring of patients at risk for aneurysm, Alzheimer's disease, and Parkinson's disease, as well as many heart and lung conditions.

HHT algorithms are coded in C++ and, when compiled, can be executed on any PC or workstation running the Windows 95 or NT operating system.

For More Information

If you are interested in more information, or want to pursue transfer and commercialization of this technology, please contact:

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